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CORN EARWORM CONTROL — SPRAYING METHODS[1]

J. W. WILSON
Central Florida Experiment Station

The rapid rise in the acreage planted to sweet corn in Florida began with the growing season of 1947-48. Scruggs (1950) reports 6,000 acres for that year, 12,000 acres for the following season and a doubling of the acreage again during the 1949-50 season. Prior to the 1947-48 season small acreages of various varieties were planted in many of the vegetable growing areas of the State. This very rapid increase in sweet corn acreage is attributed to the introduction of hybrid varieties adapted to Florida growing conditions and the development of DDT as a control measure for the corn earworm (*Heliothis armigera* Hbn.).

Russell, in 1944, reported on the first use in Florida of DDT dust for the control of *Heliothis armigera.* In 1945 Blanchard and Sattherwait reported on their experiments with DDT in oil solutions and in emulsions, and in June 1949 Blanchard et al. made recommendations for field applications of a white mineral oil and 25 percent DDT emulsion for the control of corn earworm on sweet corn. Kelsheimer et al. published, in 1950, results of their experimental work and recommended the use of a five percent DDT dust.

During December 1950 Dr. E. G. Kelsheimer, N. C. Hayslip and the writer decided to devote the coming season to a study of the use of oil and DDT emulsion. An experimental plan of procedure was drawn up. The problem was divided into three phases, with Kelsheimer to study number and timing of spray applications at Bradenton; Hayslip to study insecticide formulations at Ft. Pierce, and the writer to study spraying methods at Sanford. Later W. H. Thames was asked to study number and timing of spray applications at Belle Glade.

This paper reports on the experimental work conducted at Sanford during the past spring (1951).

METHODS: All of the spray treatments were applied by a high pressure Myers spray pump with a 25-gallon tank mounted on a Farmall model A tractor. Agitation was obtained by carrying the overflow to the bottom of the tank by means of a half-inch pressure hose. This arrangement gave adequate agitation,

[1] Florida Agricultural Experiment Station Journal Series, No. 20.

because at no time during the spraying operations was free oil observed on the top of the spray solution in the tank. A four-row boom, adjusted to the height of the ears, delivered the spray to the plants. This spray boom was so constructed that it was possible to use five nozzles to each row. One nozzle was placed directly over the row and sprayed straight down, one on each side of the row about six inches below the top nozzle, and another on each side of the row and about 18 inches below the first pair of side nozzles. These side nozzles could be turned through an arc of 180 degrees. Thus it was possible to direct the spray at any angle or height required to reach the silks.

Two plantings of corn were made. The first was Ioana, planted March 18, and the second was Calumet planted March 26, 1951. The plots were four rows wide, 40 feet long and the rows 30 inches apart, with about 12-inch spacings between plants in the row. Alleyways 12 feet wide separated each block and two rows were skipped between each two plots to allow for driving the tractor along one side of each plot. Each treatment was replicated six times. The Ioana corn was treated April 26 and May 2 for budworm control with one quart of 25% DDT emulsion per 100 gallons of spray, applying about 85 gallons of spray material per acre. The Calumet corn was similarly treated for budworm control but the dates of these treatments were not recorded.

The Ioana corn began to tassel May 2 and the Calumet on May 21. First silks appeared in the Ioana planting May 7 and the first spray applications were made May 8. First silks appeared in the Calumet planting May 24 and the first spray applications followed the next day. Spray applications were spaced at three-day intervals, with a total of four for the Ioana and five for the Calumet plantings. The 25% DDT emulsion was prepared in the laboratory, using the following formula:

25% DDT (by weight) Setting point 89°C.
72% Xylene (by weight)
3% Triton x 155 (by weight)

The mineral oil was Blandol, supplied by L. Sonneborn Sons, Inc., having the following specifications: water white, U.S.P., viscosity 90° to 95° Seyboldt. The basic mixture consisted of 3 quarts of the above described 25% DDT emulsion, 2.5 gallons of Blandol and water to make 100 gallons of spray. Details of the treatments are given in Table 1.

TABLE 1.—DETAILED EXPLANATION OF TREATMENTS APPLIED TO SWEET CORN PLOTS AT SANFORD, FLORIDA, DURING THE SPRING OF 1951.

Section A. Amount of liquid spray per acre.

Basic formula composed of 3 quarts of 25% DDT emulsion, 2.5 gallons of Blandol in 100 gallons of water using a pump pressure of 100 pounds per square inch, and 4 nozzles per row. In each case the plan was to apply 3 quarts of 25% DDT emulsion and 2.5 gallons of oil per acre. The spray solutions were mixed on the assumption that the amount of liquid applied would be approximately the same as the nozzle rating.

Treatment Number

1. Teejet Nozzle No. 650050, rated at 15 gallons per acre.
2. Teejet Nozzle No. 6501, 25 gallons per acre.
3. Teejet Nozzle No. 6502, 50 gallons per acre.
4. Teejet Nozzle No. 6503, 100 gallons per acre.
5. 5% DDT dust applied by rotary hand duster.

Section B. Kind of nozzles.

All plots treated with spray composed of 3 quarts of 25% DDT emulsion, 2.5 gallons of Blandol in 100 gallons of water, pump pressure of 100 pounds per square inch and 4 nozzles per row.

Treatment Number

1. Teejet Hollow Cone Nozzle.
2. Christian Nozzle.
3. Teejet Flat Fan No. 6503.
4. Tiger Nozzle (Manufactured by Field Force Sprayer Co.).
5. Untreated Check.

Section C. Number of Teejet Flat Fan No. 6503 Nozzles per row.

All plots treated with same formula and pressure as used in Section B.

Treatment Number

1. Two nozzles per row (low and directed downward).
2. Three nozzles per row (2 as in Treatment No. 1 and other over row).
3. Four nozzles per row (1 high and 1 low each side of row).
4. Five nozzles per row (4 as in Treatment No. 3 and 1 over row directed straight down).

Section Da. Operating pressure.

All plots treated with same formula as used in Section B., with 4 nozzles per row arranged as in Section C-3. The Teejet Flat Fan No. 6503 was the nozzle used.

Treatment Number

1. 60 pounds per square inch.
2. 100 pounds per square inch.
3. 200 pounds per square inch.

Section Db. Operating pressure.

All factors same as in Section Da except that the Teejet disc type nozzle was used.

Treatment Number

1. 60 pounds per square inch.
2. 100 pounds per square inch.
3. 200 pounds per square inch.

Counts of the number of eggs on silks of twenty ears of corn selected at random from each treatment were made on May 15 in the Ioana planting and on May 26 for Calumet. On these dates the percent of silks upon which earworm eggs were found ranged from 20 to 70 in the Ioana planting and from 50 to 90 in the Calumet planting.

RESULTS AND DISCUSSION: A record was made of the amount of spray applied to the six plots of each treatment at the time of the second spraying of the Ioana planting and last spraying of the Calumet planting. Since the tractor was operated in the same gear and presumably at the same speed it was assumed that the amount of liquid applied to the plots of each treatment would remain constant. A comparison of the data presented in Table 2 for the Ioana planting and Table 3 for the Calumet planting shows a wide variation in the amounts of liquid recorded for the same treatment in the two plantings. One explanation for this variation is that slight errors in the measurement of the liquid used would be magnified when calculated on an acre basis.

TABLE 2.—AMOUNTS OF LIQUID SPRAY, OIL AND TECHNICAL DDT APPLIED TO PLOTS OF THE IOANA PLANTING, CALCULATED ON AN ACRE BASIS, AND THE NUMBER OF WORM FREE EARS HARVESTED.

Treatment	Liquid Spray Applied, Gals.	Oil, Gals.	Tech. DDT, Lbs.	Worm Free Ears	
				No.	%
Section A. Amount of liquid spray per acre.					
1. Teejet No. 650050	72	12.0	7.20	120	50.0
2. Teejet No. 6501	81	8.1	4.86	216	90.0
3. Teejet No. 6502	144	5.2	3.12	150	62.5
4. Teejet No. 6503	144	3.6	2.16	193	80.4
L.S.D. (19-1)				24	

Section B. Kinds of nozzles.					
1. Teejet Hollow Cone	198	4.95	2.97	172	71.6
2. Christian	108	2.70	1.62	143	59.6
3. Teejet Flat Fan	99	2.47	1.48	173	72.1
4. Tiger	189	4.72	2.83	131	54.6
5. Check				9	3.7
L.S.D. (19-1)				28	
Section C. Number of Teejet Flat Fan Nozzles per row.					
1. Two	90	2.25	1.35	62	25.8
2. Three	108	2.70	1.62	165	68.7
3. Four	126	3.15	1.89	192	80.0
4. Five	198	4.95	2.97	201	83.7
L.S.D. (19-1)				18	
Section Da. Operating pressure, 4 flat fan nozzles.					
1. 60 lbs./sq. in.	117	2.92	1.75	192	80.0
2. 100 lbs./sq. in.	146	3.65	2.19	185	77.1
3. 200 lbs./sq. in.	207	5.17	3.10	209	87.1
Section Db. Operating pressure, 4 Teejet disc nozzles.					
1. 60 lbs./sq. in.				107	44.6
2. 100 lbs./sq. in.	72	1.80	1.08	114	47.5
3. 200 lbs./sq. in.	90	2.25	1.35	155	64.6

Differences in Sections Da and Db not significant.

TABLE 3.—AMOUNTS OF LIQUID SPRAY, OIL, AND TECHNICAL DDT APPLIED TO PLOTS OF THE CALUMET PLANTING, CALCULATED ON AN ACRE BASIS, AND THE NUMBER OF WORM FREE EARS HARVESTED.

Treatment	Liquid Spray Applied, Gals.	Oil, Gals.	Tech. DDT, Lbs.	Worm Free Ears	
				No.	%
Section A. Amount of liquid spray per acre.					
1. Teejet No. 650050	108	2.70	1.62	46	19.2
2. Teejet No. 6501	144	3.60	2.16	100	41.7
3. Teejet No. 6502	.....	.....	.....	39	16.3
4. Teejet No. 6503	135	3.37	2.02	20	8.7
L.S.D. (19-1)				37	
Section B. Kinds of nozzles.					
1. Teejet Hollow Cone	171	4.27	2.56	72	30.0
2. Christian	153	3.82	2.29	33	13.7
3. Teejet Flat Fan	135	3.37	2.02	25	10.4
4. Tiger	144	3.60	2.16	13	5.4
5. Check				5	2.1
L.S.D. (19-1)				22	

Section C. Number of Teejet Flat Fan Nozzles per row.					
1. Two	162	4.05	2.43	7	2.9
2. Three	162	4.05	2.43	19	7.9
3. Four	135	3.37	2.02	24	10.0
4. Five	198	4.95	2.97	90	37.5
L.S.D. (19-1)				17	
Section Da. Operating pressure, 4 flat fan nozzles.					
1. 60 lbs./sq. in.	.....	.....	.....	94	39.2
2. 100 lbs./sq. in.	135	3.37	2.02	53	22.1
3. 200 lbs./sq. in.	.....	.....	.....	136	56.6
Section Db. Operating pressure, 4 Teejet disc nozzles.					
1. 60 lbs./sq. in.	81	2.02	1.21	3	1.3
2. 100 lbs./sq. in.	99	2.47	1.48	9	3.7
3. 200 lbs./sq. in.	108	2.70	1.62	8	3.3
Differences in Sections Da and Db not significant.					

An additional treatment consisted of 5% DDT dust applied by a rotary type hand duster with the nozzle directed slightly above the silks of the upper ears of corn. Applications were started in the early morning of the same day as the first spray applications and continued at 2-day intervals for a total of six applications for the Ioana planting and seven applications for the Calumet planting. It is interesting to note that for the Ioana planting 50 percent of the ears harvested were worm-free, as compared with 3.7 percent from the untreated check, and for the Calumet planting 8.7 percent worm-free ears were harvested from the DDT dust plots as compared with 2.1 percent worm free ears from the check.

CONCLUSIONS: From the data presented it is concluded that the Teejet nozzle No. 650050 had too small an orifice, breaking the spray droplets into such small particles that there was an insufficient deposit of the oil - DDT on the silks. In both the Ioana and the Calumet planting the highest number of worm-free ears was harvested from plots treated with the Teejet Flat Fan nozzle No. 6501.

In the Ioana planting the Teejet Hollow Cone nozzle and the Teejet Flat Fan No. 6503 were equally effective. In the Calumet planting the Teejet Hollow Cone nozzle was the most effective. Both of these are wide-angle nozzles. That is, the spray is delivered over a wide area, increasing the chances of wetting all of the silks.

There was no significant difference between the number of worm-free ears harvested from the plots treated with 4 and 5 nozzles to the row in the Ioana planting. Five nozzles to the row was the most effective arrangement in the Calumet planting.

Differences between the various pressures used were not significant in either the Ioana or the Calumet plantings. However, the highest number of worm-free ears was harvested from plots treated with the Teejet Flat Fan nozzle No. 6503 in both plantings.

After the third application of spray materials the treated plots of the Ioana planting were noticeably yellow in color when compared with the untreated plots. No differences between treated and untreated plots could be detected after five applications in the Calumet planting. Total yield figures for both plantings did not indicate a reduction in yield due to the effects of the oil - DDT treatments.

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SCREW-WORM SURVEYS IN THE SOUTHEASTERN STATES 1944-1951 [1]

A. L. SMITH AND C. C. SKIPPER

Surveys in the Southeastern States were begun in 1944 by the U. S. Bureau of Entomology and Plant Quarantine, to determine the incidence and relative abundance of screw-worms, *Callitroga americana* (C. & P.). The primary objective of these surveys was to keep the livestock industry and the distributors of screw-worm remedies informed regarding distribution and abundance of screw-worms. Livestock owners were informed of available screw-worm remedies and how to use them. Livestock-management practices were outlined to reduce the number of screw-worm cases. Information on the distribution and abundance of the pest formed the basis for allocation of critical materials for screw-worm control, and manufacturers and distributors were in a position to supply remedies where they were needed.

The information on screw-worm distribution and abundance was obtained by personal contacts with livestock owners, agricultural extension officials, agricultural experiment station personnel, county agents, vocational agricultural agents, Soil Conservation Service field personnel, Bureau of Animal Industry inspectors, Fish and Wildlife Service biologists, veterinarians, and merchants.

During the years 1944 to 1948 screw-worms overwintered only in the peninsular portion of Florida. The northern limit of overwintering during those years extended in a line across the State from Fernandina to Perry and to the Gulf, while the southern limit extended from St. Augustine to Gainesville and to the Gulf.

During the extremely mild winter of 1948-49 screw-worms overwintered practically over the entire area infested the previous summer, or a radius of 200 to 250 miles north and west of the normal overwintering area. Screw-worms were active that winter over Florida, except for a few counties in west Florida, along the Atlantic coast to Charleston, South Carolina, approximately the southern half of Georgia, and a small area in southeastern Alabama.

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[1] Presented at the Meeting of the Florida Entomological Society at Winter Haven, September 14, 1951.

Owing to this wide range of overwintering, screw-worms spread to areas of the Southeast where they had never been known to occur before. Populations were extremely high in some areas, and loss to the livestock industry was heavy.

A serious situation then arose, since many stockmen and farmers in areas where screw-worms normally do not occur were inexperienced in the control of this pest. In these areas it was necessary to set up an educational program, which dealt with methods of prevention and control. News releases to the press, circular letters to livestock owners, radio-broadcast programs, and public meetings were handled through the Agricultural Extension Service.

Once the overwintering areas were established, forecasts were made of the distribution of screw-worms. Warnings were sent out from the Bureau to extension officials in all the Southeastern States. Through county agents and the educational program, livestock owners were advised of the danger of a screw-worm outbreak, were taught to recognize screw-worm cases, and were given instructions on methods of prevention and control.

Dealers in livestock remedies were requested to stock Smear 62 and other approved treatments. This procedure resulted in a fairly adequate distribution of materials. Even with this precaution, there were some temporary shortages of remedies, and ineffective control methods such as gasoline, kerosene, spirits of turpentine, linaments, and honey were applied. Some farmers in North Carolina used the last-mentioned material to induce screw-worms to come out of the wounds of animals.

By midsummer of 1949 the shortage of remedies became so acute at Whiteville, Columbus County, North Carolina, that McNeill's Drug Store chartered a private airplane to fly a cargo of Smear 62 in from Charleston, South Carolina. By the time the plane returned, it was reported that 50 to 60 people were standing in line to buy the material. It was estimated that this one county alone had at least 15,000 cases of screw-worms during the season. Some of the older veterinarians in North Carolina reported they had never seen or heard of a case of screw-worms before 1949.

The unprecedented radius of screw-worm distribution over the Southeast in 1949 covered the entire states of Florida, Georgia, Alabama, South Carolina, and North Carolina, also eastern Mississippi, southwestern Kentucky, southern Virginia, and most of Tennessee. Most of the outbreaks reported in

Mississippi, Kentucky, and western Tennessee orginated through the medium of infested livestock shipped into these areas.

In addition to those areas, a serious localized outbreak of screw-worms occurred in New Jersey in 1949 as a result of the shipment, in the latter part of April, of 704 head of feeder steers from Polk County, Florida, to the Helius Stock Farm at Jobstown, New Jersey. In the latter part of June the insects were identified as screw-worms. By the time the outbreak was brought under control it was estimated that over 1,000 cases had occurred in the area surrounding the Helius Stock Farm. This screw-worm outbreak is the only one ever known to occur in New Jersey.

The extremely mild winters of 1948-49 and 1949-50 permitted screw-worm survival over a greater radius of the Southeast than ever before. Northern limits of screw-worm survival for the winter of 1949-50 extended approximately from New Bern, North Carolina, westward to include the southeastern corner of North Carolina, the southern two-thirds of South Carolina and Georgia, and the southern half of Alabama and Mississippi, or a radius of 150 to 200 miles beyond the limit of the previous winter.

During the season of 1950, screw-worms spread over a larger area than in 1949, but population build-up was not so heavy in general, and livestock losses were not so great, because of the educational work done on preventive and control measures in 1949.

In contrast to the two previous years an opposite extreme condition occurred in the winter of 1950-51 in the Southeast. On November 24, 1950, a sudden hard freeze, followed by several weeks of low temperatures, brought screw-worm activity to an end over most of the southeastern region. The final overwintering area was established at a line extending across the state of Florida from Tampa to Cocoa—at least 125 miles farther south than screw-worms had ever been known to overwinter before. The small area of winter survival, the low winter population, and the late spring followed by a prolonged drought, all contributed to the slow population build-up and the northern migratory movement.

By the middle of August 1951 a general infestation was established in all of Florida east of Leon County. A few isolated cases were reported in west Florida and southern Georgia. The general population was still low at that time, except for

a few localized concentrated outbreaks in areas where woods hogs were abundant. These animals are important factors in screw-worm control, as they are not given the same care as other animals.

The Bureau of Entomology and Plant Quarantine developed at its Kerrville, Texas, laboratory a new screw-worm remedy known as EQ-335, the formula of which was released to the public in the fall of 1950. This smear contains 3 percent of lindane and 35 percent of pine oil, which accounts for the number "335."

This remedy has not yet become well established in the Southeast, owing to short demand for remedies this year and a large carryover of materials on hand from last year. The material is rapidly gaining favor and is the most effective screw-worm remedy now known.

MANUFACTURER, DEALER AND GROWER RESPONSIBILITIES IN HANDLING HIGHLY TOXIC PESTICIDES

JOHN J. DIEM
Southern Agricultural Insecticides, Palmetto, Florida

The purpose of this paper is to review, for workers in economic entomology, some of their responsibilities regarding the manufacture, sale and use of highly toxic pesticides.

The cataclysmic expansion of our list of economically available chemicals for use as pesticides has placed economic entomology in a position where, for all practical purposes, the art precedes the science. That is to say, we are finding and using many compounds simply because they have been found to do a job by the trial and error route of investigation. We know little of why a certain compound is a highly efficient insecticide while its chemical isomers, much less its chemical first cousins, are more often than not virtually useless as insecticides. Our inability to predict toxicity from structure leaves us with a void that makes us treat almost all pesticidal compounds as separate entities. The mention of this void is not in criticism of the trade nor the workers doing basic research on the relationships of structures to toxicity but merely to point out that this handicap intensifies our responsibilities to the general public, for where the building blocks are not too firm we must build with extreme caution. Recent popular articles and the investigations by the Delaney Committee all indicate the growing public awareness of the industries obligations.

A discussion such as this seems to outline itself on the basis of the chronology of events from the manufacturers production of a pesticide to its eventual use in the field. Keystone of the statutory law regulating the sale of pesticides is the Federal Insecticide Act of 1947 and its state law counterparts. It goes without saying that distribution of a pesticide on a national scale means conformity with all the divergent state laws and the federal law as well. A few years ago this was one of the difficult problems of the industry, but constructive cooperation by the industry and the various state legislatures is bringing about a degree of uniformity which is a credit to the industry. These laws in general perform two groups of functions, they assure the farmer as to quality and afford protection to the public in general from damage by the use of the product either directly or indirectly. The quality phase of the law involves

inspection, sampling, and chemical analysis by the United States Department of Agriculture and various state governments, thus insuring against adulterated products. The registration procedure makes quite certain that the product will do the job for which it is intended.

I will not dwell further on the quality aspects of the laws for the needs of performance are obvious, however, it might be well to point out that even the accidental production of an adultrated product might cause serious crop damage, even if it has no phytotoxic effect on the crop itself, by failure to do the intended job. While such damage is often difficult to prove, negligence is present and the manufacturer can be held liable.

Protection to the public is obtained through the following labeling restrictions:

1. The directions for usage, where toxic residues are potential danger, give adequate timing instructions.
2. The instructions for usage with such compounds as parathion contain specific instructions to operators handling the application of the material as to protective equipment and other safety instructions.
3. Warnings are clearly stated to prevent accidental poisoning. Antidotes, when available and deemed necessary, are also a part of the label. Artificial coloration for arsenicals and some fluorides is also necessary.
4. Most recently, precautions to the user with regard to possible damage by drift of the pesticide to other property in the immediate proximity have been required as a part of the precautionary statements. While it is by no means a part of the law, most manufacturers also use a non-warranty clause, the fine print of the label, in an attempt to limit their liability of the product to the chemical analysis. The validity of this clause is of doubtful value.

Violation of the federal insecticide act and most of the state laws is a misdemeanor; however, the liability implications of civil suit can be far more costly to the manufacturer.

The general rule is that a contractor, manufacturer, or vendor is not liable to third parties who have no contractual relations with him for negligence in the construction, manufacture, or sale of the articles he handles. However, highly toxic insecticides must, by nature, be considered articles which are inherently dangerous and as such the manufacturer or vendor may be liable for damages without proper warning of a danger which might not be apparent to another.

Assuming that the manufacturer has placed on the market a properly labeled reputable product for sale, it then becomes

the responsibility of his sales organization to see that the product is handled and used according to the manufacturer's recommendations. Sales organizations must be on guard to prevent the over-zealous sales representative from extenuating the precautions or extending product claims, for it must be understood that an agent or employee may do an act or make a statement that not only is not authorized, but is actually prohibited by his employer. Still if it is within the apparent scope of his employment and done in course of principals, business persons dealing with him have the right to depend upon appearance. That is, insofar as the public is concerned, the employees or agents authority may be real or it may be apparent, and the public may rely on either, unless in case of apparent authority the circumstances are such as to put a customer on inquiry.

By accepting benefit of agents act or representations the employer ratifies.

These are general rules and in any particular situation the facts must control. Time does not permit a development of this broad field of law; however, the implications of its application to salesmen, branch managers and possible liability of manufacturers and dealers is obvious.

Of course the employee or agent who does an unauthorized thing is personally liable for loss resulting to person dealing with him, and is also liable to the employer or principal for loss caused by his unauthorized act; however, financial irresponsibility of the employee usually renders this right or indemnity of no practical value.

Dealers' responsibilities parallel those of the manufacturer with respect to sales effort and the same admonitions regarding the extenuation of precautions and broadening of manufacturers claims apply here.

There are two other points regarding the merchandising of highly toxic pesticides with which it is the duty of the dealer to acquaint himself. First, the personnel should be properly cautioned as to the dangers inherent in the product. They should be carefully instructed and protective equipment made available to them so that they can clean up spillage from broken containers which is bound to occur when handling these materials in glass or paper. That this danger to employees handling these materials exists, can be seen by the exclusion of responsibility for damage caused by handling that has crept into most manufacturers non-warranty clauses in the past ten years.

Second, the matter of warehousing these materials should be given more consideration than the average seed, feed and fertilizer dealer gives. There is very real danger of storing highly toxic insecticides with feed or foodstuffs. For, again, breakage of packages occurs all too easily and the dosages of these materials in feeds would not have to be very great to cause trouble.

Storage of weed killers also presents a special problem for contamination of adjacent spray materials or fertilizer packed in paper, from a leaking drum of liquid weed killer, can produce damage to a considerable acreage.

From the dealer the product passes to the grower or the custom applicator. It is this point in the chain of sales that is one of the most problematical phases of the industry. For the industry produces a legion of materials, most of them inherently dangerous, and they must pass in large quantities to as variable a consumer as the American farmer. We are all aware of the newness of many of the tools we work with and it takes time to build up a body of case law; however, there seems to be enough case law arising from spraying and dusting operations to give the farmer some basic principles by which to govern himself when using pesticides.

First, the farmer must choose the right product. This product must do the job without injury to the crop and without possibility of leaving a harmful residue on his produce which would carry through to the consumer. This means that he must be aware of the timing limitations of his pesticide.

Second, he must see to it that his own personnel are familiar with the poisonous nature of the materials they are using, that they are supplied with the proper safety equipment and know how and do use it. It may be well to add here that while farm labor is not included under the Florida Workman's Compensation Law the employer can elect to come under the provisions of the law with a rate of about $1.92 per $100.00 of payroll.

Third, he must be aware of his rights and obligations with regard to the effect of his spraying operations on his neighbors property. There is no doubt that farmers have the right to use the many beneficial dusts and sprays, in fact their necessity to efficient production is a fact rather well established by recent testimony before the Food and Drug Administration hearings on residue tolerance. However, such preventive measures cannot be used with absolute impunity. The owner of an area dusted or sprayed with a pesticide known to be dangerous say

negligently spread the material in such a manner as to endanger stock or other property of persons in the immediate vicinity and become liable to damage therefrom. The plaintiff has the burden of proving that it was the pesticide used that caused the damage; also that the defendants were guilty of negligence on account of the manner in which the material reached adjacent fields; and that such negligence was the proximate cause for the damage. The hiring of independent contractors such as airplane sprayers and dusters would appear to offer a means of avoiding liability. Generally, the employer is not liable for the negligence of an independent contractor; however, this is not true in this case, for again we must take into account the fact that we are dealing with an inherently dangerous substance. The damage due to negligent application should be apparent to the owner and he cannot delegate the work to avoid the liability. It is true that lack of previous experience has been the basis for holding the owners not liable for damage, as in certain cases involving the use of 2-4-D dust on rice. However, as our use of dangerous pesticides expands this should become an ever decreasing basis for defense for damages caused. When it becomes necessary to apply pesticides where there is adjacent stock, notice to or knowledge of impending operations can affect the owners liability. It is best that this be handled by cooperation of grower and adjacent land owners. In regard to trespassing stock on the owner's land, the plaintiff cannot recover damages unless the poison was distributed wantonly, maliciously, or with deliberate intent to said stock.

In summing up these grower problems, it would be safe to say that almost all of them resolve themselves into reading the entire label carefully and proceeding with all the precautions stipulated, and back this with some honest to goodness common sense.

It is a real tribute to the pesticide industry that they have produced the tremendous dollar and tonnage volume; have marketed this to as mutable a customer as the American farmer; and in so doing have not built up any great body of case law.

In closing; it may be well to point out that the high ethical standards of doing business which is the rule with most companies handling highly toxic pesticides is good business. It is well to understand that neglect of a moral obligation when working with inherently dangerous products may cost you money in a court of common law.

EXPERIMENTS IN 1951 ON CONTROL OF THE CITRUS RED MITE

PAUL A. NORMAN AND HERBERT SPENCER [1]

Control of the citrus red mite (*Paratetranychus citri* McG.), also known as the purple mite, has become an important problem in Florida in recent years. Experiments on control of this pest were started in 1937 (Spencer *et al.* 1949, 1951). Oil emulsion or emulsive-oil sprays at ½ to 1⅔ gallons per 100 gallons of water give adequate control, but such applications are in addition to the regular sprays and accordingly are costly to growers. Moreover, they may injure the trees in cold weather or in very dry periods. Dry Mix No. 1 (40-percent dinitro-*o*-cyclohexylphenol) is effective, is compatible with wettable sulfur, and is used in the cooler months, but may cause injury in hot weather. Much needed is a miticide that can be added to the regular sulfur sprays.

In 1951, at Fort Pierce, Florida, an experimental grove of Temple oranges was set up with 10 blocks and 9 miticide treatments randomized in single-tree plots in each block. Late in March citrus red mite infestations were high in this grove, an estimate showing that 61 to 71 percent of the leaves were infested. Only one unhatched egg or crawling stage was enough to classify a leaf as being infested. Infestations of 20 percent or less require no control.

The following commercial products were included in the experiments:

Neotran—A wettable powder containing 40 percent of bis(*p*-chlorophenoxy)methane.

Sulphenone (R-242)—A wettable powder containing 35 percent of *p*-chlorophenyl phenyl sulfone and 15 percent of related sulfones.

Hypozene 70—A wettable powder containing 70 percent of azobenzene.

EPN-300—A wettable powder containing 27 percent of O-ethyl O-*p*-nitrophenyl benzenethiophosphonate.

Metacide—An emulsive liquid containing parathion 6.6 percent, O,O-dimethyl O-*p*-nitrophenyl thiophosphate 24.5 percent, related organic phosphates 2.7 percent, emulsifier 66.6 percent.

Genitol 923—An emulsifiable concentrate containing 50 percent of 2,4-dichlorophenyl benzenesulfonate.

No. 883 and Ovotran (K-6451)—Wettable powders containing 50 percent of *p*-chlorophenyl *p*-chlorobenzenesulfonate. Ovotran is micronized.

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[1] United States Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine.

Aramite-15W—A wettable powder containing 15 percent of 2-(*p*-tert-butylphenoxy)-1-methylethyl 2-chloroethyl sulfite.

An emulsive oil—Standard No. 345 spray oil with 38 ml. of Triton B-1956 (a glycerol phthalic alkyd resin) emulsifier per gallon. Viscosity of oil 114 seconds Saybolt at 100°F.; unsulfonatable residue (A.O.A.C.) 73.5 percent.

These miticides were used in combination with other materials. Except when otherwise indicated in the table, all plots received 3 pounds of basic copper sulfate, 5 pounds of wettable sulfur, and 1 pound of 15 percent parathion wettable powder per 100 gallons.

The first sprays were applied on April 4, 1951. A pre-spray estimate of infestation by red mites was taken on March 28, and post-spray estimates were made on May 8 and June 12. The results are shown in Table 1.

TABLE 1.—CONTROL OF CITRUS RED MITES ON TEMPLE ORANGE TREES SPRAYED WITH VARIOUS MITICIDES. SPRAYS APPLIED APRIL 4, 1951.

Miticide	Quantity of the commercial product per 100 gallons	Percentage of Leaves Infested on—		
		March 28	May 8	June 12
Neotran	1 lb.	66	40	58
Sulphenone	2 lb.	71	89	....
Hypozene 70	½ lb.	70	96	....
EPN-300	½ lb.	66	70	....
Metacide*	1 pt.	71	98	....
Genitol 923	1 qt.	64	37	67
No. 883	2 lb.	62	31	60
Ovotran (K-6451)	¾ lb.	68	34	64
Emulsive oil**	1 gal.	61	21	15

* Parathion omitted.
** Wettable sulfur and parathion omitted.

The high infestation on March 28 was probably favored by the dry weather that had prevailed for about 3 months (January had 0.69 inch of rainfall, February 2.98 inches, and March 0.73 inch), and by the application in February of a nutritional spray containing zinc, copper, and manganese.

Between April 4 and May 9, 9.9 inches of rain fell, nearly half of it the first five days after spraying. Emulsive oil gave the best control under these wet conditions. Neotran, No. 883, Genitol 923, and Ovotran gave 40 to 50 percent reductions in infestations in spite of heavy rains. Sulphenone, Hypozene 70, and EPN-300 were used at half the concentrations at which the

same materials were used in our experiments in 1950, when they looked very promising. Apparently the concentrations were too low for good control in this year's rainy season.

Since the infestations in the trees treated with the three last-named materials and with Metacide were so high on May 8, these trees were eliminated from this experiment and were set up in a second experiment. They were resprayed on May 9, as shown in Table 2, which also gives the results of the tests. Metacide was not used after the first experiment, because it showed no value for control of citrus red mites.

TABLE 2.—CONTROL OF THE CITRUS RED MITE ON TREES SPRAYED MAY 9, 1951.

Miticide	Quantity of the commercial product per 100 gallons	Percentage of Leaves Infested on—	
		May 8	June 12
Sulphenone	4 lb.	89	18
Hypozene 70	1 lb.	96	59
EPN-300	1 lb.	70	12
Aramite-15W	2½ lb.	98	11

At the concentrations used Aramite-15W and EPN-300 gave excellent control. Between May 9 and June 13 only 3.91 inches of rain fell, and 2.82 inches of this fell the third week after spraying. In our mite experiment last season azobenzene (Hypozene 70), at the concentration used, gave the best control of all the new miticides used, but this year it reduced the infestation to only 59 percent.

This season emulsive oil gave immediate and the most lasting control of the citrus red mite of any of the materials used.

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BIOLOGY OF THE AMERICAN GRASSHOPPER IN THE SOUTHEASTERN UNITED STATES [1]

L. C. KUITERT [2] AND R. V. CONNIN [3]

INTRODUCTION

The American grasshopper, *Schistocerca americana* (Drury), commonly referred to as the bird grasshopper, has been present for a long time in most areas throughout the South but only rarely in damaging numbers. Injurious outbreaks have been restricted to the sandy upland localities extending from southern Florida northward along the ridge and fanning out into northern Florida, southern Georgia and Alabama.

Occasional reports of grasshopper damage have been received from Florida and Georgia for many years past but injury was usually restricted to widely scattered areas and to small portions of fields. Numerous reports of serious destruction of corn and other crops in north central Florida and south central Georgia by American grasshoppers were received by agricultural workers in June of 1950. Surveys of the affected area in Alachua and surrounding counties in Florida by representatives of the Agricultural Experiment Station and Extension Service at once revealed that the grasshoppers were much more widespread than in former years, the insects were extremely numerous over relatively large areas, and they had caused material damage to late corn and peanuts.

The causes of this extraordinary abundance of *S. americana* in south-central Georgia and north-central Florida during 1950-51 are difficult to ascertain. Popular local opinion attributes the unusual numbers to the mild winters of 1948-49 and 1949-50. Some credence can be placed in this belief, as the official Weather Bureau Station at Gainesville, Florida, did not record a minimum temperature of freezing, or lower, during the winter of 1949-50 and there were only two minimum readings of 32 or lower for the winter of 1948-49. Although the authors did not evaluate the importance of parasitism, it appeared to be a very significant factor in some areas. Since the several areas of highest parasite abundance were located in low-ground situations, and since

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temperatures are usually 3 to 5 degrees colder than on high-ground, we wonder if the previous mild winters could have been a deterrant to the development of parasites.

Another factor which could well be of some importance is the tremendous increase in acreage of winter cover crops grown in the area. Oviposition occurs most frequently in fields which were under cultivation the preceding year. There is but little tendency to oviposit in pastures but early instars are found in these areas; however, such fields have always been situated close to a "laid-out" cover crop field.

The grasshoppers were considered of sufficient importance to warrant study and investigation. Two main phases of investigations were explored; namely, biology and control. The information in this paper is restricted to results of the studies and observations made on biology.

This insect has a life history somewhat different from the majority of grasshoppers. It overwinters as an adult and lays its eggs in March and April, while most other species lay their eggs in the fall and overwinter in the egg stage. There are two generations a year. Hereinafter, to avoid confusion, when reference is made to the first or spring generation, it concerns those individuals which hatch during April and May from eggs deposited by females which live through the fall and winter months. The second or summer generation consists of individuals which hatch during August and September. Adults developing from these nymphs are present during the fall and winter months and are occasionally referred to as the overwintering generation.

DESCRIPTION OF THE EGG AND IMMATURE STAGES

The eggs of *S. americana* are light orange in color, smooth, widest in the middle and tapering uniformly to both ends. Measurement of a series of 25 eggs gave a range in length from 7.14 to 7.59 mm., with an average of 7.56 mm.

Since these biological studies were made incidental to control investigations time did not permit us to rear individual specimens to determine the number of nymphal instars. It is the opinion of the writers that there are six instars. This is based on measurements and morphological differences, such as the number of antennal segments and the size and shape of the wing pads. In addition, several first instar "clusters" or "groups"

found in a peanut field were caged in the field and observations made involving development, type of damage, and habits.

The first-instar nymphs when newly hatched are 6-7 mm. in length. They have a slender, fragile looking body and a large head. They are pale green in color with a distinct black mid-dorsal line extending the length of the thorax and abdomen. The antennae have 13 segments and the eighth segment is longest. The eyes are large and dark reddish-brown in color. The posterior femora are usually faintly marked on the exterior side with three black horizontal bars. No trace of wing pads is present in this instar.

The second-instar nymphs average 12-13 mm. in length. The head continues to be relatively large and bears prominent dark eyes. The antennae usually have 17 segments but on occasion there may be 18. Wing pads are now present as small but indistinct lobes. In this and succeeding instars there are two general body colors. One is predominantly black and the other is predominantly green. The dark individuals, while not totally black, are heavily marked with black or dark red lightly interspersed with yellow or green. The green forms are light green in color with one prominent black mid-dorsal line extending the length of the head, thorax and abdomen. Specimens of both colors usually have the horizonal black stripes on the exterior side of the posterior femora, although it is more pronounced in the dark individuals.

Third-instar nymphs average 16-18 mm. in length. The antennal segments vary in number from 19 to 20, with the latter number occurring most often. Wing pads are present as distinct triangular flaps or lobes with the point of the triangle directed obliquely ventrad. The color pattern of the third instar is the same as in the second.

The fourth-instar nymphs have an average length of 22-25 mm. and the antennae have 22 segments. The tegmina and wing pads are inverted in this instar (see Shotwell). The point of the triangular pad is now directed obliquely dorsad. The pads are appreciably larger and the venation is now distinct.

Fifth-instar nymphs average 27-30 mm. in length and have 23 or 24 segments in the antennae. No changes in the color pattern take place.

The sixth-instar nymphs range in length from 35-45 mm. The antennal segments number 26 in this instar.

ADULT CHARACTERISTICS

This is a large, rather slender-bodied species. The body length of the females is often 2.3 inches and of the males 1.5 to 1.7 inches. The overall length of the females measured from the tip of the head to the tip of the tegmina when closed is often 2.7 inches, while that of the males is 2.1 inches. Adult specimens when freshly molted are very handsome creatures. The general body color is a reddish-brown with a slight vermilion tint. The tegmina, thorax, and abdomen have numerous brown patches. A prominent light yellowish mid-dorsal line is present on the head and pronotum and extends posteriorly to midway of the length of the closed tegmina. The basal half to three-quarters of the posterior or anal margin of the tegmina is a light yellowish color. This light band is broadest just beyond the point of attachment of the tegmen to the body, begins to narrow gently about midway of the posterior margin and fades out completely on the distal third of the tegmina. When the tegmina are closed these light margins form a continuous stripe with the mid-dorsal stripe on the head and pronotum.

It was noticed that collections of adults made during August and September 1950 always included specimens of two general body colors. In addition to that described above the general body color of some specimens was a light straw-yellow with the darker area being brown. Considerable speculation existed regarding the reasons for the two color forms. As the season progressed it was noticed that the reddish-brown forms were present in increasing numbers. With the approach of winter the yellowish colored individuals began to disappear. A collecting trip made on February 10, 1951, in Alachua County, Florida, netted an estimated 8000 specimens and all were of the dark reddish-brown color. About the first of March it became apparent that the adults, especially the males, were changing in color from the maroon reddish-brown to a bright yellow interspersed with brownish areas. The color change in the females became noticeable a short time later. As these individuals grew older the yellow color became brighter and all traces of the reddish color were lost. The times of the color change correlated with the development of the gonads and it is believed to be associated with the maturation of the testes and ovaries. In general, the changes in coloration found in *S. americana* are similar to those found by Uvarov in *S. gregaria*. The presence of both color

forms at the same time in the adult population during August, September, and October is due to an overlapping of generations, while that in the spring is due to the variation in time of the occurrence of the color change in different individuals.

BIOLOGY

FOOD PREFERENCES.—One of the most astonishing features observed in this grasshopper is the relatively small amount of food eaten by the adults. Evidence of their feeding could be found wherever the grasshoppers occurred, but this was surprisingly light in view of the enormous numbers of the insects present in some areas. Evidence of feeding was observed in corn, oats, peanuts, rye, and lupine fields and they have been reported damaging tobacco and small vegetable plantings. It was found that much of the damage to rye and oats attributed to the American grasshopper was actually caused by certain small, ground-inhabiting species. In tests where young tobacco plants were offered as food to caged *S. americana* specimens the plants were fed on sparingly. Other crops injured by American grasshoppers include hairy indigo, sugarcane, hegari, and other grain sorghums. In addition to these cultivated crops, feeding by these grasshoppers was observed on the foliage of oaks, wild cherry, holly, myrtle, ground oak, guinea grass, ragweed, and dog fennel.

HABITS AND BEHAVIOR.—The overwintering adults prefer "laid out" or idle fields with a good weedy undergrowth interspersed with numerous tall weeds or bush type trees. In numerous instances adults were found in large numbers along the margins of wooded areas in which the stand was light enough to allow considerable sunlight to penetrate to the ground. Observations indicated that the insects never penetrated densely wooded tracts.

Adults move freely, but aside from the movement from the breeding areas to cultivated fields there has been no indication of migration. Although rather short flights of about 20 to 50 yards appear to be the rule, the grasshoppers may fly considerable distances when disturbed. During the winter months there is a regular daily movement of the insects from the trees and shrubs in the tree line to the open fields in the morning and a return to the trees and shrubs in the afternoon. Sunlight and temperature are probably the most important factors in this

movement. Although the reason for this movement has not been determined, it appears that the insects might be seeking a warmer or drier situation than is found near the ground. It has not been learned what proportion of the grasshopper population makes the daily journey from trees to field and return but it appears to be large.

The activity of these insects can be correlated with temperature and sunlight. It was found that on bright sunny mornings the grasshoppers could be flushed readily at temperatures of 45-50 degrees F., while on cloudy mornings they did not flush at temperatures of 62 degrees F.

It was observed on a number of occasions during the fall and winter that the grasshoppers might be extremely numerous in a field or other localized area one day and several days later it might be almost impossible to find any of the insects there. When first observed it was believed that this might be due to movement from place to place resulting in a fluctuation in the population from day to day. Although some type of migration has not been ruled out, there is reason to believe that the grasshoppers were present all the time but were simply being overlooked. The coloration of these insects presents an excellent camouflage and readily permits them to go unnoticed on cool, overcast days when they remain quiet. These insects also have the habit of moving to the far side of branches, twigs, stems of grasses and weeds or other resting material so that they face their pursuer. Invariably, as the observer moves the grasshoppers move so as to keep on the opposite side of the object on which they are resting.

When disturbed the adults take to flight. The flight is initiated with a coarse rustling sound and it is usually downwind. If the disturbance is downwind, a grasshopper may make a short flight into the wind but after a short distance it usually turns and then flies with the wind. When the insect comes to rest on an object it immediately moves to the far side of the twig and draws its posterior legs into a jumping position.

The American grasshopper is a sun-loving creature. All stages of nymphs and adults in cages located so as to be shaded during a part of the day were usually found resting on the sunny side of the cage. The tendency to congregate in sunny areas was most evident in the field. In areas with heavy cover the grasshoppers tended to congregate by the thousands along the roads and in open plowed areas. On numerous occasions hundreds of

individuals were observed on the sunny side of a single telephone pole.

Early instar nymphs of both generations are gregarious and invariably group together on plants in the immediate vicinity of the hatching area. Often more than 100 first-instar nymphs were taken with a single sweep of an insect net. When disturbed they dispersed quickly but regrouped in a cluster usually within 30-40 minutes. As the season progressed it was noticed that some individuals remained in clusters until the third and fourth instar, while others dispersed over the field in the first and second instars. For a time it was believed that the dark forms mentioned in the description of the immature stages were the individuals remaining in groups while the green forms tended to scatter. Later, however, both color forms were found in the groups and among the dispersed forms.

HATCHING.—The first hatching of eggs in 1951 was observed on April 23; however, numerous second-instar nymphs were observed on April 26, which suggests an earlier hatch, probably about April 20. On April 25 hatching of twelve egg masses was observed, the majority of these occurring between 9 and 11 A.M. Close examination of several of these hatching masses disclosed that the upper eggs hatch first. The chamber in which the eggs were deposited was cylindrical with firmly packed sides. It was nearly perpendicular to the surface, approximately two inches deep, and extended to within about one-fourth inch of the surface. The first nymphs to hatch break through the surface crust and the remaining nymphs emerge through the same opening. When the nymphs appear at the surface they have already shed the amnion from the anterior portion of the body and after emerging they complete the task by shedding the amnion from the posterior portion of the body. The hatching areas and emergence holes are readily located by the accumulated cast amniotic skins.

With but a few exceptions all hatching of first generation nymphs occurred in areas that had been out of cultivation since the previous summer. Infested areas were not uniformly populated. In some instances restricted spots in a field or around abandoned homestead sites literally would be alive with grasshoppers, while adjacent areas were relatively free of nymphs. Most of the areas in which first generation nymphs were found in largest numbers were on relatively high sandy ridges having

a moderately heavy cover of weeds. These areas were, for the most part, the same fields in which large numbers of overwintering adults had been found.

COURTSHIP AND COPULATION.—Copulation of overwintering adults was first observed on January 24, 1951, at Gainesville, Florida. On March 1, 2, and 3 numerous copulating pairs of adults were observed in Alachua County, Florida. Mating continued throughout the Georgia-Florida area as late as June 1. Courtship-like actions were observed with both males and females appearing very excited. The action is usually initiated by the males at a distance of approximately two feet from the female. The male rustles its wings and darts forward about one-fourth of the distance to the female and then remains quiet for several minutes. This is repeated three or four times before the male finally takes position on the back of the female. The female usually does not move from the original position but does flutter the wings in response to the male's actions. Frequently other males were present and these were observed jostling the mating pairs in what appeared to be an attempt to dislodge the male. Most of the mating females collected had distended abdomens and well developed eggs.

OVIPOSITION.—The first evidence of oviposition in the overwintering generation was observed on March 16, 1951, when a female was found with the tip of the abdomen in the ground apparently laying eggs. Three days later female grasshoppers were observed ovipositing in one of the rearing cages. On March 19 seventeen egg masses were found along the margin of a winter wheat field in Alachua County, Florida. Of the seventeen masses found, eight were recovered whole and examined. The eggs were placed in cavities about two inches deep and were loosely held together by a gummy, frothy material and the top of the hole was plugged with this material. The eggs were not placed in any sort of a pod and the outer eggs were in direct contact with the soil. The eggs are deposited in the lower 1½ inches of the hole. The number of eggs per mass varied from 76 to 100, with an average of 85.

Oviposition continued in the overwintering generation until May 7 but became increasingly rarer after the first week of April. The peak of egg deposition probably occurred during the last two weeks of March.

Oviposition by a first or spring generation female was ob-

served first on July 23, 1951. Examination of several egg masses showed that the range in number of eggs was similar to that found in the overwintering or second generation. The average number of eggs was 83.7 per mass. Oviposition of first generation females was last observed on September 1; however, it is assumed that oviposition took place at later dates, since mating pairs were observed as late as September 17, 1951. The peak of egg deposition probably occurred during the first two weeks of August.

NYMPHAL DEVELOPMENT:—*First or Spring Generation.*—As mentioned earlier, the first first-instar nymphs were observed on April 23 and the first second-instar nymphs on April 26. Third-, fourth-, fifth-, and sixth-instar nymphs were first observed May 3, 9, 15, and 21, respectively. Adults of the spring generation were first observed on June 7 and at this time occasional first-instar nymphs were still present. Adults of the second or overwintering generation were still relatively numerous at the time when sixth-instar nymphs of the spring generation were first observed. After that the number of second generation adults decreased rapidly, although some overwintering adults were noted as late as June 26. Observations during the spring and summer indicated that there is a definite overlapping of generations. On June 26 it was estimated that 50 percent of the first generation had reached the adult stage and by July 30 approximately 95 percent were adults. Sixth-instar first generation nymphs were last observed on August 27.

Copulation of first generation adults was observed first on July 13. On July 23 and 24 large numbers of copulating pairs were observed in the Alachua County area and mating was last observed on August 27.

NYMPHAL DEVELOPMENT:—*Second or Summer Generation.*—Hatching of the second generation began the latter part of July. First-instar nymphs were first collected July 30 in 1951 and July 31 in 1950. First-instar nymphs of the first generation were last observed on June 13. Thus, it seems reasonable to assume that any first-instar nymphs observed July 30 would necessarily have to be of the second generation. In addition, the assumption that these first-instar nymphs belonged to the second generation becomes more valid when one considers the large number of mating pairs and ovipositing females observed several weeks earlier. Second-, third-, fourth-, fifth-, and six-instar nymphs

were first observed August 8, 13, 21, 27 and September 5, respectively. On August 21, when the first fourth-instar nymphs were collected, it was believed that the peak of hatch had occurred. Adults of the second generation were first collected on September 12. At the time the first second-generation adults were collected individuals of all instars were present but the majority were in the fourth instar. Some adults of the first generation were also present, so that again adults of both generations were present at the same time.

PREDATORS AND PARASITES

During the last 10 days of January and the first two weeks of February 1951 robins in large flocks were observed feeding on the overwintering adult grasshoppers in several areas in Alachua County, Florida. The robins congregated in extremely large numbers in pastures and fields which were heavily infested. Observations indicated that the robins broke off the wings and legs before eating the insects and this observation was substantiated by finding large numbers of these remains in the areas where the birds were numerous. Other birds observed feeding on grasshoppers included mocking birds, crows, and red-headed woodpeckers. Similar observations were also made in Georgia during this same period. In several fields where the hoppers were extremely numerous balls of regurgitated material were found which consisted almost exclusively of grasshopper remains. The material was characteristic of the hawks but the species could not be determined.

On April 5, 1951, numerous overwintering adults collected in Florida were dissected and found to contain from 3 to 10 dipterous larvae. Specimens of the larvae sent to the U. S. National Museum were identified by W. W. Wirth as *Sarcophaga* sp. (probably *lambdens*) of the family Sarcophagidae. On July 23 and 24 observations made in Brooks County, Georgia, disclosed that nearly all adult American grasshoppers leaving the ground were pursued by from 6 to 12 or more flies. Specimens of these flies were collected and sent to the U. S. National Museum for identification. The flies were identified by C. W. Sabrosky as *Sarcophaga* sp., of the general group Acridrophaga, which are parasitic on grasshoppers. A specific determination could not be made as all of the specimens collected were females and males are required for identification.

On March 20, 1951, a coleopterous larva was collected on a grasshopper egg mass in Alachua County, Florida. This larva was fed on *S. americana* eggs in the laboratory until April 21 and during this period eight eggs were consumed. Since the egg supply was exhausted the larva was killed and sent to the U. S. National Museum for identification. The specimen was determined by O. L. Cartwright as *Conoderus* sp. of the family Elateridae.

Early in May 1951 blister beetles, identified by W. H. Anderson as *Epicauta* sp. (probably *floridensis* Werner) and bee flies, identified by W. W. Wirth as *Systocebus vulgaris* Lw. of the family Bombyliidae, were collected in areas where nymphs of *S. americana* were abundant. In several instances it was felt that colonies of grasshoppers could be located by the presence of these insects in their vicinity. No larvae of either of these species were observed feeding on the eggs, but since it is known that they do feed on grasshopper eggs it is considered very likely that the eggs of *S. americana* constituted a large proportion of their diet. This belief is strengthened by the fact that both blister beetles and bee flies were reported more numerous this year than usual.

During August and September second generation nymphs were observed to fall prey to several species of web-spinning spiders. Also during this period several species of mantids were observed to capture and feed on nymphs.

ACKNOWLEDGMENTS

To Drs. A. N. Tissot, Florida Agricultural Experiment Station, and J. R. Parker, Bureau of Entomology and Plant Quarantine, for reviewing the manuscript and offering valuable suggestions; to Messrs. G. W. Dekle and H. S. McClanahan, Florida State Plant Board, and Andrew Fraser, Bureau of Entomology and Plant Quarantine, for bringing to our attention interesting developments in the field, informing us as to centers of infestation and for confirming many of our observations.

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MINUTES OF THE THIRTY-FOURTH ANNUAL MEETING OF THE FLORIDA ENTOMOLOGICAL SOCIETY

(Continued from last issue)

Mr. Bruce called for a report on the Auditing Committee. The Auditing Committee composed of the Secretary and C. R. Stearns, Jr. recommended the treasurer's report be accepted. Motion passed.

The Resolutions Committee, consisting of L. A. Hetrick, Chairman, George Merrill and L. S. Maxwell, submitted the following resolutions:

1. That the Society extend its thanks to Mayor L. H. Recker and the City of Winter Haven for extending their hospitality to visiting entomologists.

2. That the Society extend its thanks to Hon. Nathan Mayo, Mr. Phil Lucie, and Mr. L. C. Hughes for making the facilities of the Citrus Building available for the meeting.

3. That the Society express its appreciation to the local committee on arrangements for the many hours of work that contributed to the success of the meeting. This local committee consisted of the following members: J. T. Griffiths, Chairman, W. L. Thompson, Miss Francenia E. Fisher, R. M. Pratt, C. R. Stearns, Wayne Dean, and William Simanton.

4. That the Society express its appreciation to the various manufacturers of insecticides and application equipment for their excellent exhibits.

5. That the Society express its thanks to the Polk Packing Co. and the Citrus Experiment Station for contributing delicious orange juice.

6. That the Society express its appreciation to the members of industry who contributed to the success of the hospitality hour. Contributions were made by the following companies. American Cyanamid Corp., California Spray Chemical Corp., Flag Chemical Corp., Geigy Co., Niagara Sprayer & Chemical Co., Pennsylvania Salt Mfg. Co., Rohm & Haas Co., Shell Oil Co., Stauffer Chemical Co., Superior Fertilizer Co., Swift & Co., U. S. Phosphoric Acid Co., and Velsicol Corp.

7. That the Society express its appreciation to the men who have served so efficiently as officers during 1950-51.

President Bruce called for a report of the Nominating Committee consisting of W. L. Thompson, Chairman, M. C. Van Horn, and W. C. McDuffie:

President	John W. Wilson
Vice President	J. T. Griffiths
Secretary	Milledge Murphey, Jr.
Editor	Lewis Berner
Asst. Editor	W. P. Hunter
Executive Committee	D. O. Wolfenbarger

President Bruce then turned the chair over to the incoming president, Dr. John W. Wilson. Dr. Wilson thanked the society for the honor that had been bestowed on him.

President Wilson then appointed a committee to work on increasing the membership of the society. This committee consists of: Wayne Dean, Chairman, W. G. McDuffie and G. W. Dekle.

The business meeting was adjourned.

MILLEDGE MURPHY, JR., *Secretary*

REPORT OF THE TREASURER-BUSINESS MANAGER

September 5, 1951

RECEIPTS:		
Balance on Hand, December 2, 1950	$ 98.83	
From Registration fees (Sanford)	77.00	
From barbecue ticket sales (Sanford)	103.50	
From subscriptions to The Florida Entomologist	71.00	
From membership dues	250.50	
From authors for reprints, etc.	179.70	
From sale of back issues	63.25	
From advertisements in The Florida Entomologist	457.75	
Total	$1301.53	
		$1301.53
EXPENDITURES:		
To Pepper Printing Company	$ 877.16	
For barbecue (Sanford meeting)	92.84	
To U. of Fla. Duplicating Department, Programs, Letterheads, etc.	33.39	
Postage	32.23	
Envelopes U. S. Postoffice	36.32	
Addressograph slugs	4.97	
Bank Service Charges	5.50	
Miscellaneous, P. O. Box rent, etc.	8.40	
Total	$1090.81	
		$1090.81
Balance on Hand, September 5, 1951		
Cash	$ 2.68	
Florida National Bank	208.04	
Total	$ 210.72	
		$ 210.72
		$1301.53
Assets not shown ½ page ad	$ 10.00	
Liabilities	None	

Respectfully submitted,
L. C. KUITERT,
Business Manager

THE FLORIDA ENTOMOLOGIST

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